SANDIA NATIONAL LABORATORIES
WASTE ISOLATION PILOT PLANT

Analysis Plan For Compliance Recertification Application Performance Assessment Calculations

Task 1.3.5.1.3.1

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1. INTRODUCTION AND OBJECTIVES

In 1996 the Department of Energy (DOE) completed a performance assessment (PA) for the Waste Isolation Pilot Plant (WIPP). The PA was part of the Compliance Certification Application (CCA) submitted to the Environmental Protection Agency (EPA) to demonstrate compliance with the radiation protection regulations of 40 CFR 191 and 40 CFR 194. As required by the WIPP Land Withdrawal Act (Public Law 102-579), DOE is required to submit documentation to EPA for the recertification of the WIPP every five years in order to continue operating the site. This will require that a Compliance Recertification Application (CRA) be prepared and submitted to the EPA by November 2003.

This Analysis Plan (AP) describes the work to be conducted at Sandia National Laboratories (SNL) in support of the CRA. The objective of the work performed under this AP is to produce a replacement of Chapter 6 and performance-assessment-related appendices of the 1996 CCA for the CRA. This AP is an overview supported by a series of analysis plans that describe the work in individual areas in greater detail. Table 1 is a summary of the supporting analysis plans which can be used as a reference for the following discussion.

2. APPROACH

A PA similar to that conducted for the initial certification of the WIPP repository will be performed in support of the CRA. PA begins with an analysis of the features, events, and processes (FEPs) that may or may not have bearing on the performance of the repository. The FEPs are screened to determine which FEPs will be modeled in PA and the screened-in FEPs are formulated into scenarios that will be modeled. Scenarios are modeled using conceptual models that represent the physical and chemical processes of the repository. The conceptual models are implemented through a series of computer simulations and associated parameters that describe the natural and engineered components of the disposal system (e.g., site characteristics, waste forms, waste quantities, and engineered features). The computer simulations are developed from conceptual models that. The results of the simulations quantify the potential releases of radioactive materials from the disposal system to the accessible environment over the 10,000-year regulatory period. Figure 1 is a schematic of the expected CRA PA calculation progression.

2.1 FEPS RE-ASSESSMENT

The PA process is based on comprehensive considerations of the FEPs that are relevant to disposal system performance. A comprehensive assessment of FEPs was performed for the initial certification of WIPP; the FEPs assessment identified the features, events, and processes to be simulated in the PA. A re-assessment of the FEPs to determine if the original screening decisions are still applicable will be performed for the CRA as detailed in AP-095, *Compliance Recertification FEPs Reassessment Analysis Plan.* All FEPs will be re-considered and SNL will identify which, if any, FEPs have been modified for the CRA. Any FEPs screened in by the re-assessment will be incorporated in the PA.

Table 1. Compendium of Analysis Plans in Support of the Compliance Recertification Application

Reference Number	Title	Description
AP-084	The Migration of WIPP PA Parameter Data to the PAPDB Data Model	Governs Task 4C
AP-085	Analysis Plan for the Analysis of Direct Brine Releases Part of the Technical Baseline Migration	Governs Task 2A-2 and Task 3D
AP-086	Analysis Plan for Calculations of Salado Flow: Technical Baseline Migration (TBM)	Governs Task 2A-2
AP-088	Analysis Plan for Evaluation of the Effects of Head Changes on Calibration of Culebra Transmissivity Fields	Governs Task 2B, Task 4E, and Task 5E
AP-089	Analysis Plan for Upgrade of Operating System to Open VMS 7.3-1 and Hardware to COMPAQ Alpha ES45	Governs Task 4A
AP-093	Analysis Plan for Structural Evaluation of WIPP Disposal Room Raised to Clay Seam G	Governs Task 2A-4 and Task4C
AP-094	Analysis Plan for the Development of a Simplified Shaft Seal Model for the WIPP Performance Assessment	Governs Task 2A-1
AP-095	Compliance Recertification FEPs Reassessment Analysis Plan	Governs Task 1
AP-096	Analysis Plan for Completion of the Spallings Model for WIPP Recertification	Governs Task 2D, Task 3B, Task 4D, and Task 5D
AP-097	Analysis Plan For Deriving Radionuclide Inventory for Performance Assessment Calculations: Compliance Recertification Application	Governs Task 3A
AP-098	Analysis Plan for the Calculation of Actinide Solubilities for the Compliance Recertification Application	Governs Task 3C
AP-099	Analysis Plan for Calculations of Salado Flow and Transport: Compliance Recertification Application	Governs Task 2A and Task 5A
AP-100	Analysis Plan for Calculation of Culebra Flow and Transport: Compliance Recertification Application	Governs Task 2C and Task 5E
AP-101	Analysis Plan for Calculation of Direct Releases: Compliance Recertification Application	Governs Task 5C
AP-102	Analysis Plan for Calculation of CCDFs: Compliance Recertification Application	Governs Task 5F
AP-103	Analysis Plan for Sensitivity Analysis for the Compliance Recertification Application	Governs Task 5G
AP-104	Analysis Plan for Calculation of Direct Brine Releases: Compliance Recertification Application	Governs Task 5B

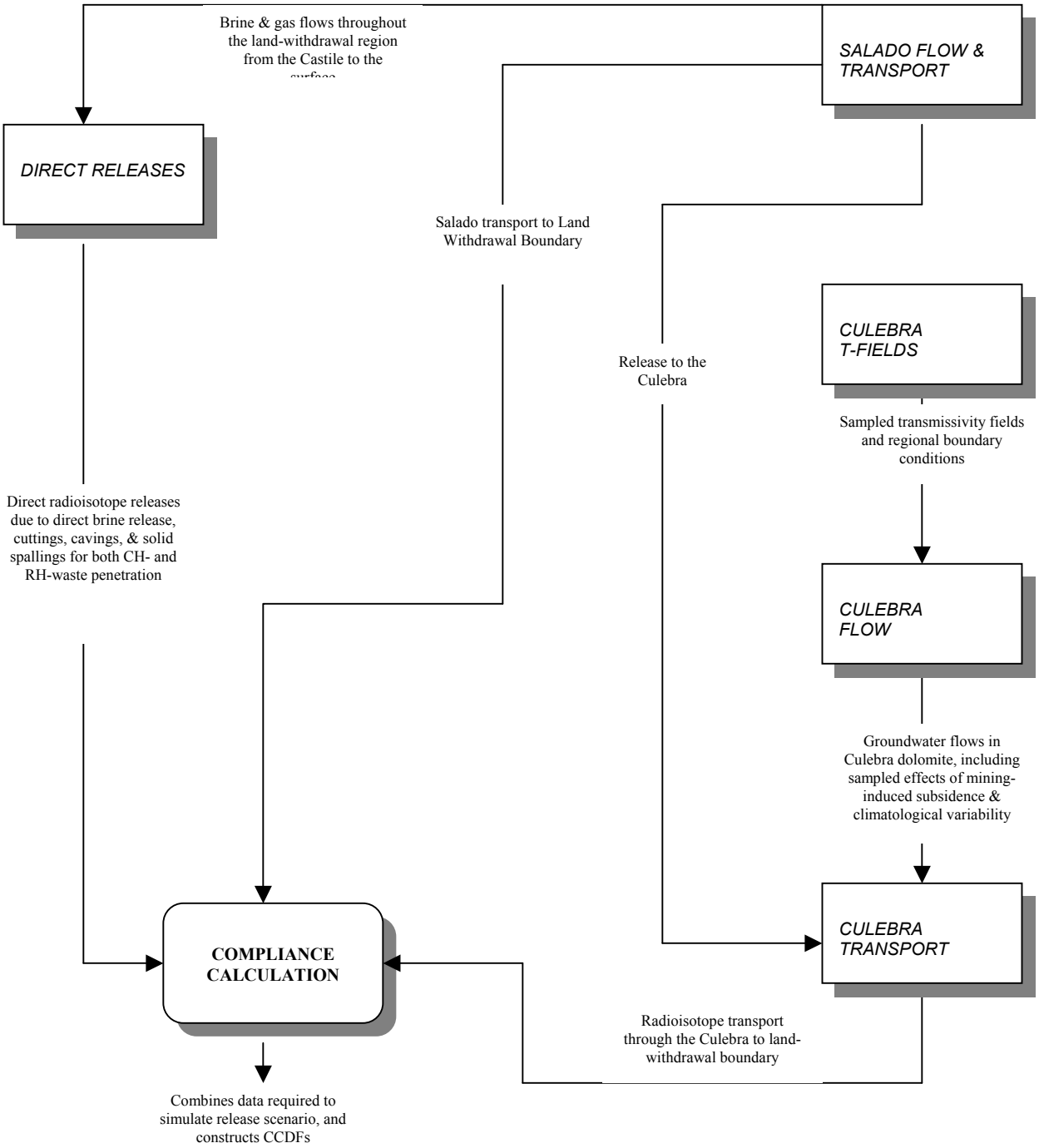

Figure 1. Overview of the expected CRA PA sequence of calculations. Modeling codes are rectangular; statistical codes have rounded corners.

2.2 PROCESS MODEL DEVELOPMENT

Since completion of the CCA and EPA's certification of the WIPP, SNL's conceptual understanding of the physical and chemical processes that control releases to the environment has improved, DOE has put in place initiatives to increase disposal rates and has proposed changes in WIPP design, and new information from the generator sites, experimental programs, and international programs has become available. The WIPP project has continued to evolve since its initial certification and this evolution precipitates changes that must be made to SNL's PA process models in order to support the CRA.

2.2.1 Salado Flow and Transport

Salado flow for the CRA will be calculated using the BRAGFLO code with its associated conceptual models and parameters. The BRAGFLO model simulates the interaction of brine, gas and the response of the surrounding host rock during undisturbed conditions and intrusion scenarios. It simulates two-phase, two-dimensional, isothermal fluid flow in porous media using a finite-difference numerical solution scheme. BRAGFLO includes corrosion and biodegradation gas-generation sub-models that simulate the effects of the decomposition of the cellulose and iron in the waste.

For the CRA, SNL will update its implementation of BRAGFLO to accommodate a new conceptualization of the repository that addresses the Option D panel closure design, new information about the behavior of the DRZ, and plans to raise the level of repository excavation to Clay Seam G, as detailed in AP-099, *Analysis Plan for Calculations of Salado Flow: Compliance Recertification Application.* The new BRAGFLO implementation is a conceptual model change and will require peer review. In addition, SNL may incorporate a new porosity surface based on an analysis of the effect of raising the repository horizon to Clay Seam G. Supporting work for AP-099 is detailed under: AP-086, *Analysis Plan for Calculations of Salado Flow: Technical Baseline Migration (TBM),* AP-093 *Analysis Plan for Structural Evaluation of WIPP Disposal Room Raised to Clay Seam G,* and AP-094 *Analysis Plan for the Development of a Simplified Shaft Seal Model for for the WIPP Performance Assessment.*

2.2.2 Direct Brine Releases

Direct brine releases for the CRA will be calculated using BRAGFLO with its associated conceptual models and parameters. BRAGFLO calculates brine released to the surface as a direct result of a drilling intrusion into the repository.

For the CRA, SNL will update its implementation of BRAGFLO to accommodate a new conceptualization of the repository that addresses the Option D panel closure design and new information about the behavior of the DRZ, as detailed in AP-104, *Analysis Plan for Calculation of Direct Brine Releases: Compliance Recertification Application.*

2.2.3 Cuttings and Cavings

Cuttings and cavings releases for the CRA will be calculated using CUTTINGS_S with its associated conceptual models and parameters. The CUTTINGS_S model estimates the direct removal of solid

wastes from the repository as the result of inadvertent penetration by a borehole drilled at some time in the future.

For the CRA, SNL will update its implementation of CUTTING_S to accommodate output from the new spallings model (described in Section 2.2.4) as detailed in AP-101, *Analysis Plan for Calculation of Direct Releases: Compliance Recertification Application.* The implementation of the new spallings model is not a conceptual model change and does not require Peer Review. It will require qualification under NP 19-1*, Software Requirements.*

2.2.4 Spallings

Spallings release for the CRA will be calculated using DR_SPALL. DR_SPALL is a new code being added to the PA suite of codes that estimates spallings releases to the surface using repository gas flow, wellbore hydraulics, and tensile failure models coupled by a cavity growth region. The spallings model is a new conceptual model and will require Peer review. The DR_SPALL code will be qualified for use in WIPP PA according to NP 19-1, *Software Requirements*. The CRA implementation of DR_SPALL is discussed in more detail in AP-096, *Analysis Plan for Completion of the Spallings Model for WIPP Recertification.*

2.2.5 Culebra Flow and Transport

New flow fields will be calculated for the CRA. Re-calculation of the flow fields for the CRA is discussed in more detail in AP-088*, Analysis Plan for Evaluation of the Effects of Head Changes on Calibration of Culebra Transmissivity Field.* The MODFLOW/PEST codes will be used in the CRA to calculate the flow fields (in 2 dimensions) in the Culebra Dolomite Member, and the lower of two water-bearing layers of dolomite within the Rustler Formation. MODFLOW and PEST are new codes being added to the PA suite of codes. These codes will be qualified for use in WIPP PA according to NP 19-1, *Software Requirements.*

The Culebra flow field that results from MODFLOW, coupled with nuclide transport from the waste panel into the borehole from PANEL, will be input for the Culebra transport calculation for the CRA. SECOPT2D calculates nuclide transport in the Culebra to the accessible environment outside of the WIPP's controlled area. For each flow field from MODFLOW, SECOTP2D combines the flow results with material and transport parameters that affect radionuclide transport in the Culebra. For the CRA, SNL will update its implementation of SECOTP2D to accommodate the flow fields generated by MODFLOW as detailed in AP-100, *Analysis Plan for Calculation of Culebra Transport: Compliance Recertification Application.* However, none of the activities in the area of Culebra flow and transport constitute conceptual model changes and do not require Peer Review.

2.2.6 Calculation of Compliance

CCDFGF will be used in the CRA to assemble results obtained from calculations from the principal physical models into complementary cumulative distribution functions. CCDFGF combines all the calculated release data to simulate many different repository histories, generating random sequences of future events, calculating the probabilities associated with those random sequences and, preparing in

numerical format, all the data required to produce the complementary cumulative distribution functions plots that summarize the WIPP's predicted performance.

For the CRA, SNL will update its implementation of CCDFGF to accommodate the Option D panel closure design as detailed in AP-102, *Analysis Plan for Calculation of CCDFs: Compliance Recertificaton Application.* The CCDFGF implementation for CRA will be qualified using NP 19-1, *Software Requirements.*

2.2.7 Sensitivity Analysis

A sensitivity analysis will be performed on the results of the CRA PA calculations. The sensitivity analysis will be conducted under AP-103, *Analysis Plan for Determination of Parameter Sensitivity Analysis for Compliance Recertification Application.*

2.3 PARAMETER DEVELOPMENT

The PA calculations that supported EPA's initial certification of the WIPP repository used a large number of parameters as inputs to computer models. The values of many parameters were uncertain; consequently, parameter values for calculations were sampled from appropriate distributions.

In 1997, the EPA required a verification of the calculations done for the CCA, termed the Performance Assessment Verification Test (PAVT). In its review of the CCA, the EPA identified a subset of the CCA parameters whose values and distributions were in question. EPA then required that DOE use revised parameters in a new PA calculation (the PAVT calculation) that subsequently became part of the WIPP's regulatory basis. In addition, since the PAVT, errors were identified in the parameters for the baseline calculation that required correction.

SNL has performed a reconciliation of the parameter sets used for the CCA and the PAVT and established a single parameter set for the CRA. This reconciliation is documented in Hansen and Leigh, 2002 and incorporates corrections to documented parameter errors. In addition to the reconciled parameter baselines, SNL will update the inventory parameters and actinide solubilities.

2.3.1 Waste Inventory

The waste inventory for the CRA will be the actual inventory of waste disposed in WIPP plus revisions to the estimated inventory expressed by the generator sites. Collection of the waste inventory data will be conducted by Los Alamos National Laboratory (LANL) under AP-092, *Analysis Plan for Transuranic Waste Baseline Inventory Report (TWBIR) Revision 4.* Calculation of the radionuclide parameters needed for the CRA PA will be conducted by SNL under AP-097, *Analysis Plan For Deriving Radionuclide Inventory for Performance Assessment Calculations: Compliance Recertification Application.*

2.3.2 Repository Chemistry

Actinide solubilities for the CRA will be re-calculated with updated thermodynamic data using the FMT code. EQ3/6 will be used to confirm the FMT results. Re-calculation of actinide solubilities will be conducted according to AP-098, *Analysis Plan for the Calculation of Actinide Solubilities for the*

Compliance Recertification Application. None of the conceptual models on which the solubilities are based will be revised and the colloidal actinide concentrations will not be revised.

2.4 PLATFORM QUALIFICATION

Before performing the PA calculations for the CRA, SNL will complete its platform qualification and hardware upgrade activities outlined in AP-089, *Analysis Plan for Upgrade of Operating System to Open VMS 7.3-1 and Hardware to COMPAQ Alpha ES45*.

2.5 DOCUMENTATION

SNL will document the work performed in support of the CRA and provide to the DOE a chapter equivalent to Chapter 6 of the CCA for the CRA. SNL will provide supporting PA-related appendices for the CRA. Guidance for the documentation task is given in DOE 2003.

3. SOFTWARE LIST

The software to be used for the PA calculations supporting the CRA are listed in Tables 2 and 3 below. Table 2 lists the software that will not be modified for the CRA and the current version number for the software. Table 3 lists the software that will be updated for the CRA.

Table 2. Software That Will Be used Under the Current version Number for the CRA

Code	Version
ALGEBRACDB	2.35
CCDFSUM	2.00
EPAUNI	1.14
EQ3/6	7.2c
FMT	2.4
GENMESH	6.08
ICSET	2.22
LHS	2.41
MATSET	9.10
NONLIN	2.0
MODFLOW	1.6
PANEL	4.00
PEST	5.5
POSTLHS	4.07
POSTSECOTP2D	1.04
PREBRAG	6.00
PRELHS	2.30
PRESECOTP2D	1.22
RELATE	1.43
SANTOS	2.1
SECOTP2D	1.41
SUMMARIZE	2.20

Table 3. Software That Will Modified for Use in the CRA

Code
BRAGFLO
CCDFGF
CUTTINGS_S
NUTS
POSTBRAG
PRESECOFL2D

4. TASKS

	Estimated Begin Date	Estimated End Date
Task 1: FEPs Re-Analysis (AP-095)	11/1/02	6/1/03
Task 2: Process Model Development	9/27/02	6/3/03
Task 2A: Salado Flow & Transport Model Development (AP-099)	9/27/02	2/28/03
Task 2A-1: Shaft Seal Analysis (AP-094)	9/27/02	11/30/02
Task 2A-2: Panel Closure System Analysis (AP-085 & AP-086)	9/27/02	1/30/03
Task 2A-3: Peer Review Presentation	2/1/03	2/10/03
Task 2A-4: Disturbed Rock Zone/Clay Seam G Analysis (AP-093)	9/27/02	2/28/03
Task 2A-5: Develop CRA BRAGFLO & BRAGFLO_DBR Grid	11/1/02	2/28/03
Task 2B: Culebra Flow Model Development (AP-088)	11/1/02	4/7/03
Task 2C: Culebra Transport Model Development (AP-100)	3/3/03	6/3/03
Task 2D: Spallings Process Model Development (AP-096)	10/31/02	4/14/03
Task 2D-1: Peer Review Presentation	3/17/03	3/26/03
Task 3: Parameter Development	10/31/02	5/12/03
Task 3A: Inventory Parameter Development (AP-097)	11/1/02	5/12/03
Task 3B: Spallings Parameter Development (AP-096)	10/31/02	4/14/03
Task 3C: Actinide Source Term Parameter Development (AP-098)	11/1/02	4/30/03
Task 3D: Direct Brine Release Parameter Development (AP-085)	9/27/02	1/30/03
Task 4: Code Platform/Preparation	11/1/02	4/1/03
Task 4A: Platform Qualification (AP-089)	11/1/02	1/31/03
Task 4C: Parameter Qualification (AP-084)	11/1/02	2/28/03
Task 4B: CCDF-GF Code Revision (Hansen 2002)	11/1/02	12/16/02
Task 4C: SANTOS Code Update/Qualification (AP-093)	12/16/02	1/14/03
Task 4D: Spallings Code Qualification (AP-096)	11/1/02	4/7/03
Task 4E: Culebra Codes Qualification (AP-088)	12/1/02	2/28/03
Task 4F: Culebra Transport Pre-processor Code Revision	3/3/03	4/1/03

Task 4G: CUTTING_S Code Revision	11/1/02	11/30/02
Task 5: CRA PA Calculations	1/2/03	9/1/03
Task 5A: Salado Flow Calculations (AP-099)	3/3/03	6/2/03
Task 5B: Direct Brine Release Calculations (AP-104)	4/1/03	7/1/03
Task 5C: Direct Release Calculations (AP-101)	4/1/03	7/1/03
Task 5D: Spallings Calculations (AP-096)	4/1/03	7/1/03
Task 5E: Culebra Calculations (AP-088 & AP-100)	4/1/03	7/1/03
Task 5F: Compliance Calculations (AP-102)	5/1/03	7/30/03
Task 5G: Sensitivity Calculations (AP-103)	6/2/03	9/1/03
Task 6: CRA PA Documentation	5/1/03	9/1/03
Task 6A: CRA Chapter 6	5/1/03	9/1/03
Task 6B: APPENDIX PA	5/1/03	9/1/03

5. SPECIAL CONSIDERATIONS

No special considerations have been identified for this analysis.

6. APPLICABLE PROCEDURES

Analyses will be conducted in accordance with the quality assurance (QA) procedures listed below.

6.1 TRAINING

Training will be performed in accordance with the requirements in NP 2-1, *Qualification and Training*.

6.2 PARAMETER DEVELOPMENT AND DATABASE MANAGEMENT

Selection and documentation of parameter values will follow NP 9-2, *Parameters*. The data entry is to be managed in accordance with the specific procedure SP 9-5, *Parameter Data Entry*.

6.3 COMPUTER CODES

New or revised computer codes that will be used in the analyses will be qualified in accordance with NP 19-1, *Software Requirements*. The platform on which the codes will be run is the COMPAQ Alpha ES40 and ES45 computers running, Open VMS AXP, Version 7.3-1.

6.4 ANALYSIS AND DOCUMENTATION

Documentation will meet the applicable requirements in NP 9-1, *Analyses.*

6.5 REVIEWS

Reviews will be conducted and documented in accordance with NP 6-1, *Document Review Process* and NP 9-1, *Analyses* as appropriate.

7. REFERENCES

DOE 2003. *Guidance and Strategy for Writing the 2003 WIPP Compliance Recertification Application*. DOE/WIPP 01-3199. U.S. Department of Energy, Carlsbad Field Office. Carlsbad, NM.

Hansen, C. 2002. *WIPP Requirements Document for CCDFGF (Version 5.00).* ERMS # 524386. Carlsbad, NM.

Hansen, C and Leigh, C. 2002. *A Reconciliation of the CCA and PAVT Parameter Baseline* Revision 2. ERMS # 524694. Sandia National Laboratories, Carlsbad, NM.